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REHABILITATION OF AREAS STRIPPED FOR COAL

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REHABILITATION OF AREAS STRIPPED FOR COAL[1/]

By

A. G. Chapman

Conservation of lands stripped for coal should be directed toward reclamation for some profitable use of value to the owners and the community, and the maintenance of such areas in an ever-productive condition. The development of effective rehabilitation and maintenance practices is essential to the achievement of this two-fold objective.

Strip mining, or open-pit mining as the operation is commonly termed, poses a relatively new and different problem in the broad field of "return of unproductive lands to gainful use." Although this method of mining has been used in a crude way for centuries--and probably was the first method--it was well after the close of the First World War that strip mining attained its present high level of efficiency in coal production. The development of more powerful and faster equipment capable of removing deeper overburden--all the rock and soil strata above the coal seam--has greatly increased the rate of production and the acreage which can be mined. In some states, the output of strip mines now equals that of deep or shaft mines.

Strip mining resembles plowing with a break plow on a tremendously enlarged scale. In rolling and steeper terrain where coal deposits or seams outcrop, mining begins at the crop line and progresses by succeeding contours until the overburden becomes too thick to make the recovery of coal economical.

Open-pit coal production is largely concentrated in the Central States region. The greatest producers are Pennsylvania, West Virginia, Kentucky, Ohio, Indiana, Illinois, Missouri, Kansas, and Oklahoma. A few other states outside this region,

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such as Alabama and Arkansas, also produce considerable quantities of coal by the open-pit method. Roughly 225,000 acres have been strip mined to date. The total acreage of stripped land will be rather accurately known when the survey being made by the Central States Forest Experiment Station is completed early in 1948. Some specific acreages by states, where surveys are now completed, are 32,000 acres in Ohio, 25,000 acres each for Missouri and Kansas, and 8,200 acres in Oklahoma. Two counties in Ohio have about 60 percent of the stripped acreage in the state. In Harrison County, which has the greatest amount of strip-mined land, the acreage stripped represents only slightly more than 3 percent of the land area of the county. The stripped area in this county probably will never exceed 7 percent. The total area stripped in Ohio, including all coal veins, at present amounts to only twelve hundredths of one percent of the state's 26 million acres. Although it is impossible to estimate closely the remaining strippable acreage, a liberal allowance for future stripping would not bring the total area stripped in all states to more than three-quarters of a million acres.

Twelve different coal veins or seams are strip mined extensively in the Central Region. In generally flat country, such as southeastern Kansas, there are seldom more than two seams of coal near enough to the surface to permit strip mining. But in sharply rolling eastern Ohio, seven outcropping seams are extensively strip mined, and two more may eventually be worked by this method. Because of differences in depth and type of deposits, the overburden of any one seam varies greatly from place to place in both composition and structure. A still greater variation is encountered among the overburdens of several different seams. This is due to differences in rock materials of the different geologic ages. These raw parent materials are the substances from which soils are derived. Instead of presenting a simple, somewhat uniform problem in land use comparable to a soil series, these parent materials present

one of great complexity. But rehabilitation practices applicable to each situation must be developed.

Why has so much interest and concern developed regarding these lands which now constitute only slightly over one-tenth of one percent of the total land area in any state, particularly when non-coal lands totaling many times this acreage are permitted to lie idle, deteriorate and remain unproductive? There are several reasons. Perhaps the outstanding ones are: (1) The unsightliness of bare, torn-up earth surfaces, (2) disturbance of the conventional agricultural practices and economy, (3) the general dislike of change from one kind of land use to another, and (4) recognition of the difficulty in reclaiming the spoils with profitable covers.

Associations of strip mining companies have been organized with the reclamation of the spoil banks one of their chief aims. Among these are the Ohio Reclamation Association, the Division of Forestry and Reclamation of the Indiana Coal Producers Association, the Illinois Coal Strippers Association, and the Reclamation Development Company of Missouri. In addition, there is the Land Use Advisory Committee of the National Coal Association, the primary function of which is to consider and evaluate new reclamation methods and urge their adoption by coal producers. Not only are new associations being formed as demands increase for restoring stripped lands to productivity, but membership in the present ones is growing rapidly.

The coal strippers associations are attacking the problem of reclamation realistically and objectively. This is especially true of the larger operator members. Progress until the last two or three years has been slow for two reasons. First, the establishment of vegetation under difficult conditions was new to most of their engineer-trained personnel. Second, there was little information upon which to rely regarding the successful establishment of tree or forage crop covers on spoil banks. Previous research had been spotty and grossly inadequate. Many tree plantings had been made, some as early as the

close of the First World War; but most were made on a trial and error basis and were failures. They were based largely upon old-field planting experiences and not upon a knowledge of the composition and structure of the strip banks, or spoils, on the one hand and of the soil and moisture requirements of tree and forage crop species on the other. Finally, as a result of counseling with various agricultural agencies, men trained in different phases of conservation have been employed to advise and supervise the initiation and development of this specialized reclamation program. Additional trained personnel will be required as the program expands.

There are still planting failures, but they are being rapidly reduced through acceptance by industry of the advice of technical foresters and agronomists, who urge concentration of efforts on areas known to be plantable. As research results become available for other classes of spoils, the work of reclamation can be expanded. Eventually, it is believed that research will point the way to restoration of practically all banks to some profitable use.

Let us now consider in some detail the various conditions encountered in the field, progress to date in the development of rehabilitation practices, and the approach to problems yet to be solved.

As mentioned previously, spoil banks are made up of a wide range of parent materials, all of which influence to some extent the soil that develops therefrom. Certain plants--trees, shrubs, and herbs--do well in a relatively wide range of soil conditions. Other plants, however, are more specific in their requirements, and will become established and grow only in more limited ranges of soil conditions. For this reason, the spoils must be carefully studied and classified according to present knowledge of their capacity to satisfy the requirements of various species of plants. Results of such studies will give clues as to "what will grow where." Once the plant-supporting potential of a given class of spoils is determined, it remains

only for the owner to choose, from the plants adaptable thereto, the tree, shrub or herb that best meets his needs for wood products or forage.

The banks are composed of sandstones, shales, limestones, glacial till, clays, or some combination of these materials. Except nitrogen, all mineral elements essential to plant growth are usually present in sufficient quantities to support most species of plants. Occasionally there is found an overabundance of sulphur-iron compounds. These compounds oxidize and form sulfuric acid, which may completely inhibit the establishment of plants on the bank surfaces. When small amounts of acid are present, however, plants survive and grow in accordance with their tolerance of acid conditions. Most of the forage crop legumes--alfalfa and red, white, and sweet clovers --will not grow under acid conditions. Many other legumes--alsike clover, some of the lespedezas, and black locust--will thrive on slightly acid banks.

Limestone, calcareous clays, or dolomite in the spoils tend to neutralize acid materials, and thus favor the formation of "sweet" soils. On such banks the clovers and most other legumes thrive. In fact there are few plants which do not thrive on sweet soils if physical conditions are favorable and nutrient elements present in sufficient amounts. So much for the general effects of composition on rehabilitation.

The texture of materials is also important in the vegetation of banks, since it controls the amount of air and water available to the roots of plants. Sandstones and shales usually disintegrate and settle more rapidly than limestones and dolomite. These latter sometimes require several years of weathering before becoming plantable, unless they are mixed with sufficient quantities of other less resistant materials.

In the course of bank examinations over the region, many kinds of rock and soil mixtures have been found. They may range from tight, putty-like clay to coarse sand, both mixed at times with quantities of rock. The clays become waterlogged in

wet weather, providing plenty of water but too little air for plant roots. In dry weather they become hard and yield little water to plants. At the other extreme are the coarse-textured spoils. They provide plenty of air but are poor moisture retainers and become droughty soon after rainfalls. The most desirable texture results from the weathering of fine sandstones and silty clay shales into well-aerated, non-puddling, moisture-holding banks. Fortunately, a relatively small percentage of the stripped areas have spoils that are too fine or too coarse in texture to support some kind of vegetation.

Rehabilitation of stripped lands to profitable use will involve one or some combination of the following fields: forestry, agronomy, horticulture, wildlife, or recreation. However, extremely few areas will be suitable for cultivated crops.

Forestation. The planting of forest trees for wood production will undoubtedly continue to play a major role in reclaiming spoil banks. Both hardwoods and pines have been planted on various classes of spoils, but for the most part the older plantations were established on a trial and error basis not productive of conclusive evidence on such questions as adaptation of species to a wide range of bank conditions, the relative merits of different planting methods, etc. Nevertheless, information obtained from these plantations contributed to the planning of a systematic attack on the overall problem, and provided a basis for preliminary recommendations to owners interested in forestation.

Information gained from the older plantations has been supplemented with observations on natural stands which developed on certain banks in the vicinity of a good seed source. The species most likely to reproduce naturally on banks include cottonwood, aspen, sycamore and red gum in the northern areas, and these with shortleaf and loblolly pines in the southern states. All normally require exposed mineral soil for their seed germination and seedling survival, and are recognized as pioneer species on bare lands. Spoil materials where such

natural reproduction occurs have been analyzed for composition and structure to obtain additional information on adaptation of species to site. The successful stands studied do not bracket all spoils conditions found within the natural range of these species, but the data thus far obtained offer at least a partial answer to the question "What will grow where?"

Now let us look at the yields of a few of the older plantings and natural stands on stripped land. Observations on an eighteen-year-old black locust planting in Ohio indicate that it will yield 500 six- to nine-inch fence posts per acre, with enough additional stems to provide a good stand of growing trees for future yields. At 35 cents per post, a gross of $9.72 per acre per year could be realized. In Oklahoma, five acres of a seven-year-old black locust plantation were cut selectively--that is, crop-size trees were removed leaving a growing stock composed of well-formed, barely merchantable and smaller trees to mature for future harvests. The owner used 200 posts and marketed 800 at 25 cents, thus grossing $5.71 per acre per year for posts sold. In Indiana, a crop of pulpwood was harvested from eighteen-year-old natural cottonwood stands. With proper management, these areas should continue to produce successive harvests of valuable wood products. If desired, however, the stands may be easily converted to other species by favoring the natural seedlings of other trees now developing beneath the present stands.

Taking advantage of information provided by the older plantations and natural stands, the Central States Forest Experiment Station of the U. S. Forest Service began, ten years ago, a systematic investigation of spoil bank rehabilitation. The initial work was on a limited scale and largely confined to Ohio. As a result of this research, the problem of foresting one class of spoils--sandy and silty shales on National Forest land--was largely solved. Banks which had remained devoid of vegetation for ten years were planted to many kinds of hardwoods and conifers in pure stands. The pines, which require

little nitrogen for average growth, made a satisfactory response. The hardwoods, with the exception of black locust, survived but stagnated. Analysis of the spoil materials indicated little more than a trace of nitrogen, which explained the poor performance of the non-leguminous hardwoods. The locust, a nitrogen-fixing legume, thrived and in nine years attained post size. Later on, seedlings of other hardwoods were planted in the locust stands where nitrogen was now plentiful. In three years these seedlings were three times the height of nine-year-old trees of the same species growing on banks unimproved by the influence of locust.

Natural seedlings from seed of nearby hardwoods are now numerous and thrifty in locust stands, whereas none has developed on bare banks or in pine stands. The reason is clear. In the short period since planting, a soil profile rich in nitrogen and organic matter and thickly covered with litter is developing under the locust, forming ideal conditions for hardwood establishment and growth. Bank surfaces under the pines are still characteristically dry and poor in nitrogen. The answer to the reclamation of sandy and silty spoils of moderate acidity appears to be the planting of locust in mixture with other hardwoods which can survive the moderate shade of the rapidly growing locust.

Two years ago Congress provided special funds which enabled us to extend our investigations to a regionwide basis. Since then practically all stripped lands in the region have been carefully mapped and the spoils analyzed and classified according to soil characteristics known to influence survival and growth of planted trees. As planting investigations progress, need may arise for more refined analysis and classification.

In addition to the regionwide reconnaissance survey of stripped lands, we have established during the past two years several hundred acres of experimental plantings on various classes of spoils. These studies, which will be greatly enlarged

next year, are designed to determine: (1) species and mixtures of species best adapted to different kinds of spoils, (2) desirable weathering and settling periods before planting, (3) effects of leveling or partial leveling of banks upon their capacity to grow trees, and (4) areas better suited to uses other than growing trees.

In nature, the distribution and development of trees, like most other plants, are limited by their habits of seeding and germination, and by their particular requirements for moisture, nutrition, light, and other growth factors. No native tree has been found to survive the high acid conditions found in certain spoils. In general, coniferous species--pines, spruces, firs, hemlock, etc.--are more tolerant of acid than hardwoods. On the other hand, conifers generally reproduce poorly or not at all on sites high in limestone. Exceptions to this general rule are red and white cedars, which are well adapted to limestone banks. Most hardwoods will survive in spoils ranging from moderately acid to calcareous or alkaline conditions, but their growth within this range varies greatly with the requirements of the individual species. Generally speaking, hardwoods require richer soils than conifers.

Soil texture, light, climate and many other factors also influence the germination, survival and growth of trees on spoil banks. All must be evaluated and taken into consideration in the selection of species to plant or favor under different bank conditions. Much remains to be learned about the requirements of trees and the characteristics of spoils. To date research has only scratched the surface of the overall problem. Nevertheless, application of present information has prevented many costly plantation failures during the last few years. As additional basic information becomes available, forestation of spoil banks will become more precise and efficient.

Forage Crops. Grazing is another promising use for strip-mined areas. It is still in the development stage, but present indications are that under certain conditions forage values

compare favorably with the income from forest products. After consulting with agronomists, a dozen or more of the larger coal companies and some individuals seeded by airplane, on a trial basis, some 3,000 acres of spoil banks in Missouri, Illinois, Indiana, and Ohio. They used various mixtures of such forage legumes and grasses as sweet clover, red clover, lespedezas, orchard grass, etc. The total cost, exclusive of seed, averaged approximately $3.50 per acre.

These test seedings were confined to calcareous spoils known to be suitable for both legumes and grasses. Because of the nature of the banks it would be impractical to apply either agricultural limestone or nitrogen-carrying fertilizers. However, the need for such treatment can be minimized by planting the right species in the right place. For example, the use of nitrogen-fixing legumes in the mixture should provide sufficient of this nutrient element to support non-leguminous grasses in the otherwise nitrogen-deficient spoils.

One 600-acre grazing project begun in Fulton County, Illinois, in 1936 is reported to have netted from cattle an average of $7.00 per acre per year between 1939 and 1945, and $9.00 in 1946. The cost per acre of initial seeding, exclusive of seed, was $3.21.

Research in the grazing phase of stripped land reclamation has just started, and thus far is being conducted on a very limited scale. State Agricultural Experiment Stations of three states are collaborating with the Forest Service and coal producers in forage crop studies. This phase of the work needs greater emphasis.

Grazing specialists have raised some very pertinent questions regarding the seeding of stripped lands to forage crops. Among them are the following: (1) What mixtures of forage plants will provide the highest quality feed and at the same time stabilize the bank surfaces against erosion and stock trampling? (2) What is the livestock-carrying capacity of the vegetated banks? (3) What recognized pasture-maintenance

treatments are feasible for banks devoted to grazing? There are widely different opinions regarding the last question, chiefly because stripped lands present problems quite different from those ordinarily encountered in pasture maintenance. For example, is it necessary to apply fertilizers to spoil bank forage crops? The spoils are composed of raw parent soil materials high in the minerals necessary for crop growth. Of the essential elements, only nitrogen is ordinarily deficient. As the parent materials weather, they may be expected to release abundant supplies of mineral elements in a form readily available to plants. In spoil banks, unlike undisturbed soils, it seems reasonable to believe that it will take generations for the parent rocks to decompose to the point where leaching will substantially reduce the supply of nutrient elements available to plants growing in the banks. It appears doubtful, therefore, if spoil bank pastures will need to be fertilized to the same extent as those on undisturbed lands. Certainly fertilizing will be of little concern for the immediate future.

Clipping is another recognized pasture-maintenance measure which may or may not be feasible for spoil banks. This practice has been found to benefit permanent pastures on most undisturbed land. However, great acreages of permanent grazing lands have been kept reasonably productive without clipping. There is some question as to whether clipping of stripped lands, if possible, would increase forage yields sufficiently to justify the added cost.

These and many other problems must be investigated in order fully to explore the possibilities of reclaiming the banks for grazing purposes. In general, progress to date has been encouraging.

Fruit Growing. Stripped lands in some sections of the coal-producing region may well lend themselves to fruit production. Spoils are generally too rough for spraying and other equipment needed in maintaining orchards or smaller fruit-bearing plants, but this difficulty can be overcome by the

construction of an adequate system of access roads. In areas where the natural soils are not suited to fruit tree growth, costs of building and maintaining such roads may be justified by local scarcity of fruits. Near Pittsburg, Kansas, where the undisturbed soils are mostly too tight for fruit trees, banks have been made accessible and planted to many kinds of fruits. Those in charge of the project have reported good crops of high quality. This use will certainly be limited in scope, but will be of considerable importance in some localities.

Wildlife and Recreation. Wherever trees and shrubs can be established on stripped lands, and slightly acid or "sweet" water is available for impounding to form lakes, development of the area for wildlife and recreational purposes is not only feasible but usually in great demand. Mr. C. V. Riley, Ohio Wildlife Specialist, points out that an experimental wildlife area on vegetated spoil banks in Tuscarawas County, Ohio, has shown a much greater increase in the population of native birds and animals than adjacent unmined lands. One area in Illinois nets its owner about $300 per year from fur-bearing animals.

Lakes formed in stripped areas are often good fishing and duck-shooting grounds. Such lakes are usually stocked with fish and restocked as need arises. Some are leased to clubs. Concessions are sold on a few, where individual fishing rights are granted for small fees. Still others are open by permits to the fishing public.

Suitable park and recreational sites have been turned over as gifts in many cases to Boy and Girl Scout Troops, counties and municipalities, and other local organizations. Development to afford boating, fishing, picnicking, and swimming is common. These wildlife and recreational facilities are particularly welcomed in prairie and plains areas where natural forests and lakes are scarce.

In the foregoing discussion we have considered examples of various possible uses for the banks themselves. But what about undisturbed lands intermingled with strip-mined areas? This

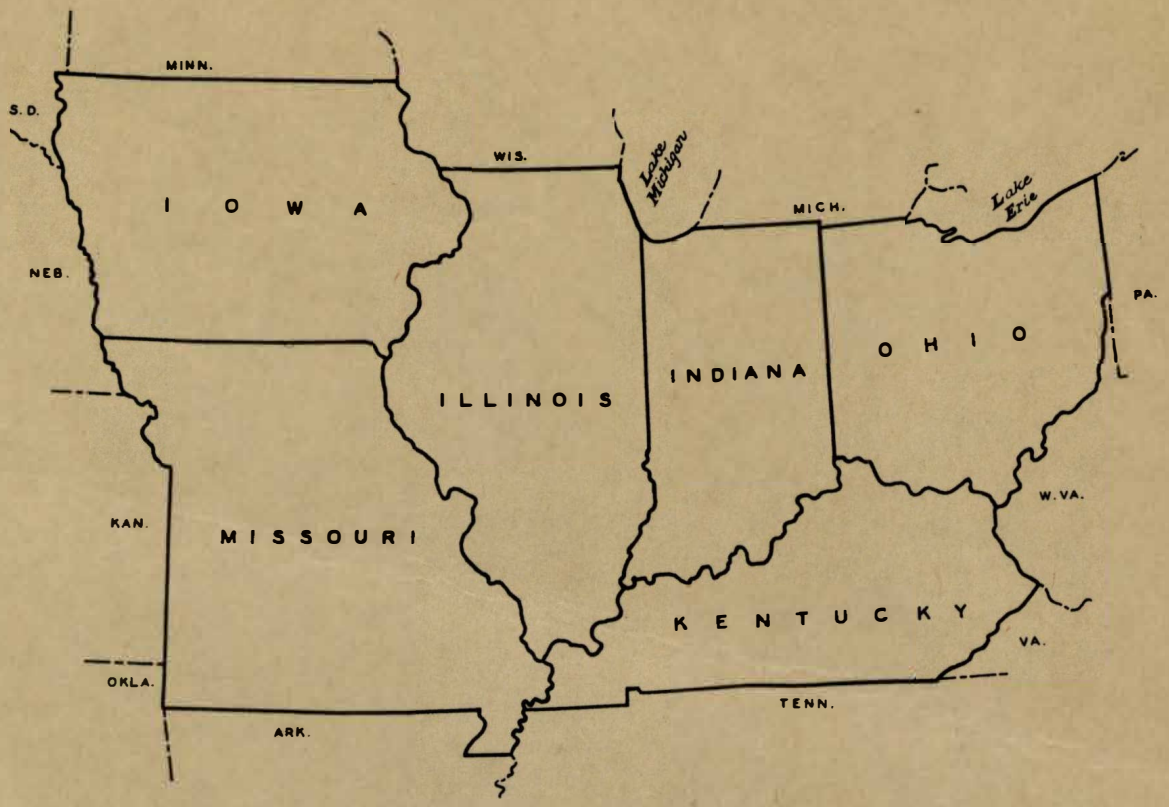
isn't much of a problem in level to gently rolling country where the overburden is nowhere too deep for removal. Here stripping is usually solid over the entire area. In more rugged country, however, where coal seams outcrop on the slopes or near the surface in the valleys, considerable land is often left undisturbed in the valleys below the seams or above the outcrops where the overburden is too thick for stripping. Here the problem is to find profitable uses for the undisturbed areas as well as the banks.

If the unmined areas are extensive and readily accessible, it is usually feasible to cultivate them or otherwise continue their former use, with new land-use practices applied only to the surrounding spoils. Continuation of the previous use, however, is impractical or impossible where the unmined lands are small, scattered and relatively inaccessible. In such cases it is best to put the undisturbed land to the same use as the spoils, making due allowance for differences in site conditions. In this connection it might be mentioned that in our forestation research, we are studying the in-between unmined lands as well as the spoils. Research on grazing and other uses should likewise be extended to include both situations.

In summary, I should like to repeat that the reclamation research of the Central States Forest Experiment Station is directed toward the development of practices which will result in the greatest benefits to the owners of stripped lands and the people of the communities in which they are located. As foresters, it is logical that we concentrate on problems of forestation. We recognize, however, that there are other profitable uses for stripped lands, and that the ultimate land-use pattern for such areas may include a combination of forestry, grazing or other uses. For this reason, we are cooperating to the fullest extent with the coal companies, State Departments of Forestry, and the agronomists and other specialists of the Agricultural Experiment Stations. The question of the highest use for various classes of banks can be answered only by at-

tacking the problem from all angles with a well-correlated program of research.

As research results become available, the present reclamation program can be made more efficient and effective. In the final analysis, the scope and momentum of this action program will depend largely upon the extent to which the coal producers and the general public are informed of the income-producing potential of reclaimed lands, and the willingness of the coal industry to put research results into practice on a large scale. Regulatory legislation, if it be found necessary to implement the reclamation of stripped lands, should be based upon factual information rather than sentiment or unsupported opinion.



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